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Standardised Industrial Housekeeping

In the Report on the Training of Young Foundrymen prepared by the Education Committee of the Institute of British Foundrymen, the question of industrial housekeeping is, by inference, relegated to the actual employers, as this was considered to be outside the scope of its activities as set out in its Royal Charter. Thus, it is of particular interest at the moment that the American Foundrymen's Association have thought fit to publish a "Code of Recommended Practices for Industrial Housekeeping and Sanitation," because herein are shown ways and means of standardising working conditions at such a level that the amenities provided will satisfy the most pernickerty of parents. The actual wording of the Report as to its scope is "This recommended good practice code describes the necessary fundamental engineering and construction information for the layout, design, installation and maintenance of wash, locker, rest, toilet and lunch rooms and general industrial housekeeping and sanitation facilities for the protection of health and safety of persons and for the promotion of good industrial relationships." Much that is recommended is the law of the land in this country, and is thus seemingly better, at least on paper. For instance, in this country there is a statutory obligation to clean fettling shop walls at stated intervals, but in this Report the matter is left to the discretion of the management. There are, however, several additional worthwhile recommendations, such as the avoidance of accumulations of dust and dirt so that when there is a sudden change in the direction of the wind or some intense vibration there shall not be a disturbance of dirt to the detriment of the breathing area. Again, major cleaning operations must be carried out when the shops are empty. It is perhaps a little amusing from the British point of view that cuspidors must be cleaned and disinfected daily! The recommendations as to eating in "certain" departments are rather drastic. Apparently they do not refer to meals, but even to the eating of "candy" or the drinking of milk in the heavy non-ferrous shops. Moreover, the employees are required to wash before eating anything at all. An obvious rider is, of course, the provision of a canteen, or at least a mess room. We gather from the Report that the overalls used by either casters or fettlers of magnesium are potential fire hazards, and when wearing these the operatives are neither allowed to smoke nor to approach anybody who is smoking. Much attention is being given to the ventilation of workshops, and the first recommendation is a minimum of 2,000 cub. ft. per person, "provided the total projected area of doors and windows opening to the out-of-doors is not less than 12½ per cent. of the gross area of the workroom, otherwise a system of mechanical air supply shall be provided." Shops which do not reach this standard must have for every 100 cubic feet at least 2 cubic feet of air per minute per person.

Provisions of a similar character are made for the offices, toilets and kitchens. Lighting is dealt with in tabular form, and, generally speaking, it is recommended that the stores and corridors carry 2½ ft. candles, boiler, sub-stations, washrooms 5, and 10 ft. candles for the actual factory, offices and canteens. Drinking and washing water are given very special attention, and plumbing methods are detailed so as to ensure hygienic conditions. It is interesting to read how the A.F.A. operating through "standards" apparently undertake the rôle which in this country is imposed by the Ministry of Labour and National Service through the Factory Acts. Though in general we prefer the British system, the American code has the advantage of including points, which are, in this country, within the sphere of the local building regulations.

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BOOK REVIEWS

Metals and Alloys Data Book. By S. L. Hoyt. Published by the Reinhold Publishing Corporation, 330 W. 42nd Street, New York, U.S.A. Price $4.75.

This is a most useful book. At a rough estimate 90 per cent. of its 334 pages consist either of tubular matter or graphs, and therefore it is in strict accordance with its title. The author has, however, written a long preface to explain how the data he has published—or indeed any data—should be used. Very rightly he draws attention to the influence of mass. It must not be thought that, because the book is somewhat massive, that it covers wide ranges of alloys of a proprietary nature, though an exception is made in connection with the special malleable irons of American origin. Most of the alloys covered—dealt with in 320 odd tables—are in general production in America, and quantity alone well justifies the collection and publication of standard data. The arrangement of the book is unique. A start is made with drawings of test specimens, followed by hardness tests, and to this subject are allotted thirteen tables. Then comes a long section on the wrought steels, which needs over 170 tables, and does not include stainless steels. This range is covered thoroughly in a later chapter. The type of data given for steel castings (dealt with in a chapter headed "The Cast Steels," to which some old boys in Sheffield would take strong exception) can perhaps inadequately be shown by selecting three headings from the sixteen tables printed. A random selection is: (1) The Effect of Mass on Medium Carbon Cast Steel; (2) Low-temperature Properties of Mn-Ti Steel, and (3) High-Temperature Tests of 4/6 Cr-Mo Cast Steels. Equally interesting tables are given for both grey and malleable cast irons. There is an excellent collection of data relative to the Ni-Cr series of heat and corrosion resistant casting alloys, the introductory notes being particularly helpful. To cover the non-ferrous alloys, about 70 tables have been included, a high proportion of which are casting alloys. After the presentation of some data relative to beryllium and tantalum, the author has thought fit to include about twenty tables of general utility, some of which take on a new form. Finally, there is a set of photomicrographs designed for ascertaining average grain size. The indexing is admirable, and the sole criticism the reviewer feels justified in making is the continued use of the word "draw" for "temper," as he is reasonably certain that official bodies in the United States have standardised on the latter expression. Hesitatingly the suggestion is also made that the use of the word columbium should not be used, because, after all, there is an international agreement to employ the word niobium.

V. C. F.

Mechanical World Year Book, 1944. Published by Emmott & Company, Limited, 78, Palatine Road, Manchester, 20. (Price 2s. 6d. net.)

This year's edition shows that its high standard has been well maintained. So far as cast iron is concerned, there is a tendency to reduce this subject to tabulating weights and thicknesses of pipes and plates to the exclusion of the more metallurgical aspects. This step is not criticised for, after all, this is a mechanical engineer's hand-book. Whilst the amount of space devoted to cast iron seems to be decreasing, that for light alloys is increasing. The book now runs to well over 250 pages and is well illustrated. The backbone of the publication is, as it should be, the tabular matter.

Adolescent Feeding. Compiled and issued by Barkers (Contractors), Limited, London.

This pamphlet is divided into two sections. The first part has been written by Dr. C. P. Stewart—the senior biochemist to the Royal Infirmary, Edinburgh, and Dr. J. C. Thompson, chief chemist to the Food Research Department of the issuing company. In it the authors detail in commonsense language the scientific diet essential to the wellbeing of youths and girls. The second part, written by the directors of the concern, outlines how the tenets enumerated by the scientists can easily be carried out in practice and the cost of so doing. It embraces a scheme for the encouragement of the taking of regular meals.

INSTITUTE CALENDAR MEETINGS FOR FEBRUARY 1944

Lancashire Branch.—"Standard Costing and Cost Control," by A. N. Wormleighton. At the Engineers' Club, Albert Square, Manchester, on February 5, at 3 p.m.

Scottish Branch.—"Fluid Pressure in the Foundry," by E. Longden. At the Royal Technical College, George Street, Glasgow, on February 12, at 3 p.m.

West Riding of Yorkshire Branch.—"The Education of Foundry Workers," by D. Jepson, M.Sc. At the Technical College, Bradford, on February 12, at 6.30 p.m.

Sheffield Branch.—"The Production of Builders' Castings," by C. Gillespie. At the Royal Victoria Hotel, Sheffield, on February 18, at 7 p.m.

Bristol Branch.—"The Application of Light Metal Castings," by J. Morgan. At the Grand Hotel, Bristol, on February 19, at 3 p.m.

East Midlands Branch.—"Mechanical Aids to Core Production," by J. Blakiston. At the College of Technology, Leicester, on February 19, at 3 p.m.

London Branch.—"Quality Control in High Duty Iron Production," by E. W. Harding. At the National Liberal Club, on February 19, at 2.30 p.m.

Falkirk Section.—"Castings Inquest." An investigation into the manufacture of certain difficult castings. At the Temperance Café, Lint Riggs, Falkirk, on February 26, at 6 p.m.

Lincoln Section.—"Mechanical Aids to Core-making," by J. Blakiston. At the Technical College, Lincoln, on February 26, at 3 p.m.

Wales and Monmouth Branch—"A Wartime Steel Foundry—Some Problems and Developments," by E. Derek Wells, on February 26.

SOME ASPECTS OF SAND CONTROL*

By F. THOMAS
(ABRIDGED)

Sand control in a steel-foundry is a sound investment and pays for itself, being simple in application and giving good clean and sound castings

The art of founding is very ancient and in the past has mainly depended upon traditional and empirical knowledge. Within recent years, however, founding has been transformed by two factors:—(1) Application of science to the study of cast metals and the subsidiary materials which are used in their production; and (2) mechanisation.

According to contemporaries the progress achieved, through the influence of the above factors, can be regarded as phenomenal. It is commendable to note that nowadays foundries are capable of producing, on a continuous production basis, castings which are uniformly and cheaply made to cover a wide range of specifications.

The demand for high quality castings which is attributed to competition within and outside the foundry industry and the maintaining of the customer's goodwill in respect to surface quality and saleability of castings has led to the extended adoption of sand control in most foundries which claim to make more than unmachined and low duty castings, and its advent has undoubtedly aided in eliminating guesswork. It is true that good castings have been made without any sand control, and the production of a good casting in days of old was only possible through a skilled moulder using his skill in "art of moulding," whilst his knowledge of fundamental sand requirements such as successful mixing, the openness and venting properties, was governed by the empirical "rule of thumb" method and not to any scientific study.

The purpose of this Paper is to attempt to show the economic value and necessity of technical sand control in producing the best possible castings and monetary saving with the materials and equipment available, considering at the same time the minimising of fettling and material cost.

The Function of Sand Control

It is now generally realised throughout the foundry industry that the condition of the sand for moulding or core making may be the cause of defective castings, consequently there is an extended use of sand testing apparatus. This apparatus is directly responsible for increasing the knowledge of foundrymen on the properties of foundry sand. However, the object of sand testing is to provide for control purposes, definite methods for determining:—(1) The qualities of virgin sands; (2) a series of records appertaining to the physical properties of the various types of sand; and (3) a safety valve as to the amount of sand-reclamation that can be effected which is directly related to the minimum percentage of defective castings, and thereby correlating data as to production costs, defective castings which are a foundry loss, and the improvement of the surface quality of castings.

The function of technical sand control is therefore:—(1) To make a correct interpretation of the results obtained from testing; (2) make a standardisation of the physical properties of sand applicable to certain types of castings; (3) determine the when and how of either sand or binder addition; and (4) the most important function of control is to maintain adequate permanent records which are accessible at any time. This ensures continuous guaranteed results.

The accuracy of sand control can be governed by the equipment available for sand handling, and the extent of control is dependent on the type of work encountered in the foundry.

Selection of New Sands

Sand control with suitable laboratory tests can be of value in selecting new sands, although it is agreed that the most exacting and the best test of a sand for moulding purposes is its practical application in the foundry itself. Even though experience is the best teacher it can be the most costly. The choice of sand for moulding, which can be successfully and economically applied, is best made after a thorough investigation of the chemical and physical properties of materials which have proved themselves to be satisfactory under the existing conditions. With this knowledge of the desired properties, it is possible to examine other sources of supply, which are more economically situated, thereby saving the foundry unnecessary expenditure. When a study is to be made of a fresh sand deposit, the investigation must incorporate the properties which are most likely to influence the behaviour of the sand when employed in making a casting.

New sand consignments are examined for the following properties:—(1) Mechanical composition—*i.e.*, grain size, shape and distribution; (2) refractoriness (allied with chemical composition); and (3) permeability. To ensure a uniformity in new sand supplies the fineness test is extremely valuable besides having a salutary effect on the producer.

Securing uniform supplies of sand ensures uniform

* A Paper read before the East Anglian Section of the London Branch of the Institute of British Foundrymen, Mr. C. H. Kain, presiding.

Sand Control

results in the mixtures for moulding purposes, and is a direct aid to sand control. The author strongly recommends that sand producers should test all consignments of sand to foundries for the fundamental properties. It is not possible in most foundries to sample every consignment of sand that is delivered, and any variation which may have occurred with a change in the topography of the sand deposit is not discovered until defective castings appear. This is obviously working backwards, the main function of sand control is to prevent as far as possible defective castings being made, not discovering the cause afterwards. The author, therefore, considers that advance knowledge of any variation in the sand supply would enable foundrymen to modify their process to suit, and with this scheme in operation much information and greater co-operation would result for both producer and consumer.

An important property for moulding or core sand is its refractoriness. It signifies the ability of the sand to withstand the high temperature of the various metals. Inadequate refractoriness in a sand connotes a tendency for the surface of the mould to fuse. This has a deleterious effect on the casting and a consequent difficulty in cleaning, besides the harmful effect on tools when castings are machined. Though the casting technique is similar for iron and steel, the difference in properties of the metal enforces a modification in moulding sand practice, *i.e.*, sands as generally used for the casting of iron and nonferrous metals can hardly be economically adopted for the casting of steel due to their lower refractoriness.

The importance of refractoriness in the steelfoundry, where a much higher casting temperature (1,600 to 1,650 deg. C.) is demanded than for other metals is obvious. One of the chief problems which has, and is still being encountered with steel castings is the difficulty due to "burning on." Many different theories correlated with appreciable data have been advanced as to the true cause or explanation of this problem. According to J. B. Caine,* "in steel practice, adhering sand is due to penetration of metal into the sand, thereby locking it on to the casting and that adherence due to fusion is very small. Metal penetration is due to large voids being present in rammed sand and decreasing the grain size (consequent decrease in refractoriness) decreases penetration and adhering sand."

Grains of sand having a low sintering point might easily fuse together, forming an impermeable face into which the metal cannot penetrate, and that with higher sintering point sand, this fusing would not take place, and "burning on" would be the result.

Action of Cereal Binder in Steel Sands

The author believes that the use of a cereal binder in the sand mixtures at the steelfoundry to which he is attached prevents "burning on" to a large extent. Cereal binder, *e.g.*, core gum, in steel sand is similar to the use of coal dust in iron sand, and functions by providing a layer of gas between molten metal and the mould so that there is no reaction between metal and mould.

The refractoriness of a moulding sand is also affected by the type of "filling in" material, *i.e.*, clay or bonding agent. If this material has a low fusion point, it influences the melting point of the whole mass to such an extent that softening is not reached owing to the lower fusion point binder reacting with the sand to form a fusible silicate. With iron, however, refractoriness is not so important except where heavy section castings are made. Most sands, when subjected to temperatures of, say, 1,300 to 1,350 deg. C. for only short periods of time, remain more or less unchanged, but, with heavy sections, if sand be too low in refractoriness, it would be burnt up and would not be fit for re-use.

Therefore, the economical point to be stressed with reference to refractoriness of sands is that, although it is possible to produce good castings with low refractory sands, it will be found necessary to use a greater amount of new sand to replace the "burnt up" or waste sand caused by metal temperature.

General Considerations of Moulding Practice

As both the iron and steel sections of the foundry, to which the author is attached, make almost 100 per cent. of their castings in synthetic green sand, a brief consideration of synthetic moulding sand will not be out of place. To quote Dunbeck, "the term synthetic sand covers any sand which is made in the foundry from materials selected and proportioned by the foundryman to fit best his particular needs."

The three main constituents of a synthetic sand are fundamentally the same as in a naturally bonded sand, *viz.*: (1) Silica sand, of the desired grain size, shape and distribution to give (*a*) the permeability required, (*b*) necessary surface finish to the castings, and (*c*) suitability to the type of metal: and (2) bonding material, of necessary binding power and refractoriness, which can be applied to control to a large extent green, dry, and hot strength, flowability, moisture and "life" of moulding mixture.

It would, the author believes, be extremely difficult to obtain a naturally-bonded sand which would be capable of maintaining a consistency in all specified values of these properties. In selecting a suitable sand it is suggested that the following points be considered:—Refractoriness, evenly graded, angular-shaped grains (greater mechanical strength, as clay adheres more firmly than with rounded grains), and rough or coated grains which take clay more readily.

There are quite a number of clays which can be used, the most commonly known being bentonite, Fulbond, Colbond, Distribond, etc. For producing green and dry strength properties, bentonite, when compared weight for weight, shows a marked superiority over the others. Owing to the war, however,

* J. B. Caine. A.F.A. Preprint 43-24.

there has been difficulty in obtaining sufficient supplies of bentonite, and it has been necessary to find a substitute. In the steel section of the foundry concerned, Colbond has been the most successful and economical. Economy depends on several factors: (1) Price of bonding material; (2) relation between desired green and dry strength; and (3) effective bond distribution.

To sum up the advantages of synthetic sand mixtures, it can be stated that a higher degree of control of variables is possible than with naturally-bonded sands. Unwanted oxides, such as FeO, CaO, can be excluded. They are more economical than naturally-bonded sands, *e.g.*, when the "life" of the clay in the latter is finished, a large tonnage of sand has to be dumped. Whilst with synthetic sand mixtures it is only necessary to revive reclaimed sand by adding bonding material. The price to be paid for

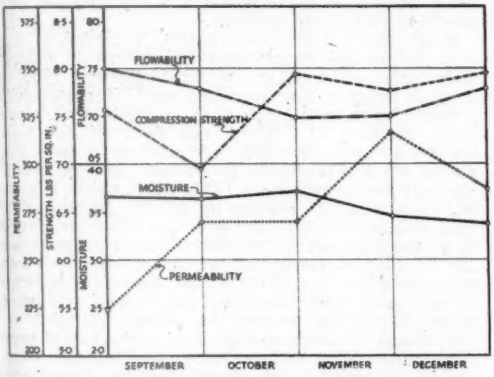

FIG. 1.—MOISTURE, COMPRESSIVE STRENGTH AND PERMEABILITY CONTROL OF SAND IN STEEL-FOUNDRY FACING OVER A 4-MONTHS PERIOD.

adopting synthetic sand is constant vigilance, and in this connection Fig. 1 shows graphically the variations experienced over a period of four months. If defective castings occur when using synthetic sand, it is not the sand which is at fault, but sand control.

Sand Reclamation

In the steel section of the foundry, where upwards of 95 per cent. of the total castings output is made in synthetic green sand (yearly figure for total defective castings is 6 per cent.), an exceedingly high percentage of reclaimed sand is being obtained. This reclaimed sand constitutes upwards of 85 per cent. in all batch mixes.

The method of reclamation employed is as follows: Foundry floor sand mixed with spent core sand (which incidentally is similar in grain size to that of the moulding sand base) is passed through a rotary drier on to a magnet belt (where core irons and nails are removed and later recovered). Then on to vibrating screens of specified mesh size, where fines and "dead" clay are separated. This renovated sand is then stored in a hopper placed immediately above the sand mills, into which it is fed when required, together with bonding material and a percentage of new sand, to make facing sand.

With this particular plant the amount of fine material is quite consistent and allows of the maintaining of permeability and strength to definite values. The value of the grading test to ensure this factor is appreciated; very little variation is found in the sand returned from the foundry, due mainly to the fact that only one type of sand is used. The properties of this sand are shown in Table I.

An interesting feature of sand reclamation is the increase in the amount of silica sand after reclamation, *i.e.*, floor sand from the foundry comprises 86 per cent. silica sand, 14 per cent. clay, of which after

TABLE I.—*Steelfoundry Sands.*

	New Sand.		Reclaimed Sand.	
	Aug. 1940.	July, 1943.	Aug., 1940.	July, 1943.
On B.S.S. sieve, No. 8 ..	Nil	Nil	0·3	Nil
,, ,, ,, 10 ..	Nil	Nil	0·3	0·2
,, ,, ,, 16 ..	0·5	0·6	0·4	0·7
,, ,, ,, 30 ..	38·2	36·4	21·8	35·7
,, ,, ,, 60 ..	52·8	54·7	53·2	48·2
,, ,, ,,150 ..	7·8	8·0	17·3	9·4
Through B.S.S. sieve, No. 150	0·5	0·3	1·7	1·1
Clay content	Nil	Nil	5·0	4·7
	99·8	100·0	100·0	100·0

reclamation 95 to 98 per cent. is silica sand, and 2 to 5 per cent. is clay. Another point to be considered is how much new sand should be added to a mixture. In the steel section the practice adopted is to add a constant percentage in each batch (10 to 15 per cent.), and as this section is not mechanised to the extent of return sand conveyors, the new sand addition is sufficient to make up for the loss due to sand adhering to castings.

It is possible to make steel castings in 100 per cent. new sand, and also 100 per cent. reclaimed sand, without any defects; but it is almost impossible in the ironfoundry to make castings in 100 per cent. new sand without encountering some defect or other. In the grey-iron foundry it has been possible to run for a period of almost six months without any new sand additions. The decisive factor, however, is that new sand additions should be kept to a minimum, consistent with (1) desired working properties, and (2) desired casting finish.

Recently, in the grey-iron section of the foundry, the "single sand" practice was put into operation,

Sand Control

but, owing to the sand-handling plant being inadequate, it has been temporarily discontinued. However, the author has reached some conclusions which he hopes will contribute to the discussion.

The use of facing sand as a mixture is costly, slows up production and aggravates, especially during war, the labour problem. After the sand has been laboriously transported all over the foundry in very small quantities, it is placed in a box—the space which it occupies could profitably be used for storing moulding boxes—ready for moulding. The moulder has then to make a separate operation of taking some of the facing to put over the pattern and then fill up with backing sand. Even then there is no guarantee that the facing may not cover the whole surface of the pattern.

In the "single sand" or "all facing" practice, where moisture, strength and permeability would be the same as for separate facing-sand mixtures, the labour problem for transport would be eliminated. The moulder would only have to pull a hopper lever and fill the mould with one operation. There is a need, however, to use a separate facing-sand mixture for special jobs, when the system sand has been found to be too rich in coal dust or the correct finish on the casting has not been obtained. The initial cost at the commencement of the "single sand" process will obviously be high, because it involves the use of excessive quantities of coal dust and bonding material in the mixture.

Coal Dust

Coal dust can be regarded as a necessary evil. Its choice is dependent upon fineness of base sand and type of castings to be made. It is accepted that the function of coal dust is to prevent metal "burning on" by forming a gas layer between the mould face and molten metal. All consignments should be analysed for volatile matter and ash—the latter, if high and of low fusion point, can be detrimental. Satisfactory results are being obtained with V.M. of 32 to 35 per cent. and ash 5 to 7 per cent.

It has been proved in the grey-iron section that the amount of coal dust added in separate facing-sand mixtures is insufficient to obtain the required amount in the system; consequently coal dust is added together with bonding material at the mill. The following points should be considered when a desired quantity of coal dust is required in the system:—(1) The percentage of new and core sands being put into the system; (2) section thickness and amount of surface of castings; (3) period of time that castings are allowed to stay in the mould; and, finally, but the most important point, (4) the surface finish of the castings. The control of coal dust is not an easy one; the method employed in this grey-iron foundry is to test for total carbon and correlate this result with the lbs. of coal dust used divided by the tonnage of metal poured.

Core-sand Practice

In dealing with another section, namely, the core-making department, there are distinct possibilities by utilising sand testing and control to determine the practical characteristics and application of the mixtures in use, thereby providing a means for economy in materials where necessary. There are two main types of core mixtures, *viz.*, dry-sand and green-sand core mixtures; the properties of the latter are governed by the existing moulding-sand practice of either the iron or steel section. All references will, therefore, be directed to dry-sand cores.

A statement made earlier in the Paper, when dealing with sand for moulding purposes, can be applied to sand for core making, although cores can be made from any type of sand. Sands are available for the production of various cores suitable for the various classes of metal. For control purposes the essential properties are moisture, green and dry strength, permeability and sintering value.

Sand with a high SiO_2 content is needed to prevent fusion and metal penetration when in contact with metal. The finish required influences type of sand; however, a coarse-grained sand, if coated with a protective material, such as silica paint (steel), plumbago, blacking, etc. (iron), can be used for high-quality finish if required. A core sand, possessing similar physical properties as the base sand for moulding purposes, is beneficial. This ensures that, if grain size is similar, no closing up of the foundry floor sand will occur. With the presence of silt or clay in core sand, the author has found that a larger quantity of binder is required to obtain suitable cores. Similarly with fine-grained sands; they have a larger surface area than coarse-grained sands, and more binder is required to coat the grains.

Problems in the core shop, such as the loss of cores in the green state and the making of intricate cores, can be controlled by the green strength. Conversely, dry strength determines the suitability of core conditions after baking. According to Hansen,* "strength required in cores to resist rough handling in the core room, in storage, and in the foundry is very much greater than is the strength required to resist stresses upon the cores once they are set in the closed mould." The amount of resistance to erosion of metal is dependent upon the dry strength. Conditions in the foundry concerned demand that cores be made several days in advance; therefore, careful choice of materials can minimise the loss of cores due to losing strength if cores are kept in a humid atmosphere.

The permeability of sand must be high enough to permit egress of gas which is evolved when metal is poured on to the core. The size and shape of the sand grains plus the amount and type of binder has influence upon permeability. The author has found that, by increasing oil-to-sand ratio, there has been an appreciable drop in permeability. Therefore, it is on information based on the characteristics of these properties that proper selection of sand and binders

* C. A. Hansen, A.F.A. Preprint 26-9.

can be made, so that ultimate core mixtures arising from their combination can be properly and economically utilised.

Effect of Clay on Oil-bonded Cores

Clay, whether added as powder form or in the form of naturally-bonded sand, absorbs a certain percentage of the oil. To obtain cores which are not mealy, it is necessary to increase the percentage of oil, with a resultant increase in the amount of gas evolved and probably the number of blown castings. According to one authority, "as clay bond is increased in a core mixture, the rate of collapsibility of the baked core is materially reduced." If collapsibility is slow, there is a likelihood of strain occurring in the casting. Conversely, if collapsibility is deficient, the core will wash, resulting in sand inclusions in the casting. However, a certain amount of economy can be obtained by substituting naturally-bonded sand for a percentage of silica sand, as (1) it provides extra green strength (therefore less loss of cores in the green state); and (2) it prevents excessive drying out of sand on the benches, *i.e.*, minimises wastage of sand due to loss of plasticity.

Core-sand Binders

There are many types of binders on the market. With regard to the characteristics of these, the author recommends a Paper given by Tipper* on "Practical Economies in Use of Core Binders," in which he gives a classification of the binders in general use, and also methods for obtaining best results with the materials, together with suggestions as to possible alternatives. There are, however, other fundamental factors which contribute to a considerable extent to the successful production of cores, and, if not recognised, will lead to an ineffective use of the materials concerned. A brief description of these factors will serve to illustrate this point.

Milling.—Core mixtures which are improperly mixed can account for a high loss of cores; increased cost of labour in making replace cores and defective castings. It is appreciated that to make successful oil sand cores, a proper distribution of the oil is essential, so that all sand grains have a thin film or coating of oil. Mixing by hand is, therefore, unsuitable and uneconomical. For good oil distribution the muller type mixer is recommended. At the foundry concerned, it was found that, with the installation of a new type "Fordath" mixer in place of a roller type mill, it was possible to reduce the oil/sand ratio on all mixtures employed and, obtaining at the same time, an improvement in the physical properties of the cores. Experience with this type of mixer indicates that cold sand should be used because the heat which arises through friction may lead to a premature drying out of the sand.

An important economical feature in sand preparation is the providing of suitable measuring equipment for adding the correct amount of sand and binder, conforming to the formula of the core mixture. For the measuring of oils and other binder types Imperial measures should be adopted. Enlightening the mill operatives as to what happens when various materials are added, etc., is a considerable help in the maintaining of a uniform quality for core mixtures. By installing clocks near the mills the operatives are able to mill the sand for the specified time.

The use of semi-solid core compound in the foundry concerned has often been the cause of loss in cores. If the barrel of compound is exposed to the atmosphere there is a decided tendency for a very hard crust to form on the top of the compound and the sides of the barrel. This crusty material will not mill out, and appears in a lumpy form in the sand; on baking these lumps "boil out" of the core, leaving cavities, with a subsequent rejection of the cores. A preventive is to place a wet sack or a thin layer of water over the compound.

Moisture is a variable which can be responsible for affecting: (1) the green strength of the core; (2) improper baking of cores by delaying oxidation period; (3) an increase in the amount of binder needed, and (4) core production, which is slowed by creating a sand mixture of poor workability and so sticking to corebox. A recent test carried out by the author was to gauge the effect of water on dry strength. Confirmation is needed, but this preliminary test showed that the more water added, the lower becomes the dried strength—what is the explanation of this? Is the oil carried away by the water vapour during the initial drying period?

For core sand mixtures, especially when oil is the binder, the sand should be dried and a specified moisture content should be added, allowing for the difference in weight, *i.e.*, dry sand being heavier than wet sand. An interesting point dealing with moisture in core sand was illustrated by Mr. Shepherd in a Paper he delivered in 1936. He stated that his firm were able to reduce sand-drying by more than 60 per cent. by utilising an amount of undried sand in the core mixtures. The moisture was carefully controlled with the aid of the Speedy apparatus. This certainly makes for fuel economy.

Baking.—Cores must be uniformly and correctly baked to obtain maximum dry strength plus minimising the amount of obnoxious fumes given off whilst casting. Time and temperature of baking are dependent on:—(1) the permeability of the sand; (2) the moisture content; (3) the amount of oil present, and (4) the type of drying stove and core drying plates and driers used, solid or perforated.

The practical guide to correct degree of baking is colour of dried core and by hand-testing a sharp edge of the core, but the author has on many occasions when the practical test has been satisfactory found, on breaking the core, that the interior is soft and oily. This condition is presumably due to too high initial drying temperature, skin drying, or too much oil. Unbaked cores can be the cause of slowing up production in the foundry by affecting the workmen with the irritating fumes given off whilst

* FOUNDRY TRADE JOURNAL, Oct. 6, 1942.

Sand Control

casting is in progress, and can also cause cracked castings because cores develop strength at the wrong time, *i.e.*, when they are encircled by hot metal.

Elimination of problems (1), (2) and (3) can be gained by careful control of the variables, and by installation and frequent inspection of pyrometers, a fixed working temperature would attend to baking problems. In the foundry concerned a rigid core inspection is maintained, this ensures that a faulty core will not be the cause of a defective casting. An economic consideration with which the core inspection department can help, is to isolate the different types of core wastes into appropriate bins. Sand can be re-used, thereby saving bond and new sand.

Conclusion

Manufacturers of castings for financial reasons must produce castings of good quality, at low production costs plus consideration of the health of the labour utilised. So far economical and good results of sand control, which is still in its infancy, must be fostered. Sand control is an investment and will pay for itself. It is not a complicated process; it is simply a method of obtaining and maintaining a correct and uniform sand with which to make good clean sound castings, which is the sole object of the foundry industry at large. The author expresses his gratitude to his firm, Lake & Elliot, Ltd., for permission to present the Paper, and especially to Mr. C. H. Kain for his encouragement.

DISCUSSION

MR. H. H. SHEPHERD, who opened the discussion, said he was glad that stress had been laid on the practical application of sand control, as, although testing and recording were all very well, they were, broadly speaking, a waste of time and effort unless some definite benefit was obtained as a result of their application. As to the conversion of the sand system to all facing, against the use of a separate facing, he could not, from the point of economies, altogether agree with Mr. Thomas. In his own case, it definitely would not be an economical proposition, and, furthermore, in a plant such as he was connected with, the continuous heat input due to heavy production was a potential source of trouble. It was, he considered, one of the cases where each foundry must decide for itself. Referring to the casting heat input, he felt that Mr. Thomas's figure of 100 deg. C. was rather conservative, as, in his opinion, a temperature of from 200 to 250 deg. C., dependent on the type and weight of casting, was more acceptable.

On the question of control of coal-dust additions, although he agreed that various methods had been devised, he would like to know what was the lecturer's objection to the commonly employed "Loss on Ignition" test.

Coal-dust Control

He regarded the section of the Paper on core-sand grain size and shape as containing some excellent information, but, contrary to the lecturer's opinion, he felt that it was important that the grain size should not be too uniform, as the inclusion of a small proportion of fine sand helped to avoid cracking of the core on drying. In stressing the importance of thorough and correct baking, he believed that a common fault in core drying—and one not always appreciated—lay in baking first, before driving off the moisture, thus preventing essential oxidation, by the "blanketing" action of the water.

MR. THOMAS, in reply, said he had in general no objection to the loss on ignition coal-dust control test, but, in applying this test himself, he had obtained very inconsistent results, leading to castings with a poor finish, and in some cases actually to defective castings. On the other hand, control by total carbon estimation had given him good results, and, from experience with this, he had fixed a figure to be maintained.

Regarding Mr. Shepherd's objection to sand-grain uniformity, he considered that, if uniform, a minimum amount of binder addition was used, whereas with a non-uniform grain-size sand, more binder was required to give the same bond figure. Furthermore, as the grain size actually governs the finish of the mould and consequently of the casting, in his opinion, marked unevenness in grain size would express itself in a rough casting finish.

MR. SHEPHERD, elaborating his point, said that at one time the fewer number of mesh sizes retaining the sand on test, the better it was liked, but he believed the tendency now was to include a small proportion of fine sand to give a spreading of the bulk over 3- or 4-mesh sizes instead of the previously preferred 2-mesh sizes. This proportion of fine sand helps during baking to even out the expansion, and so preventing excessive cracking.

Sand of Uniform Grade Undesirable

MR. C. H. KAIN thanked the lecturer for showing the main function of sand control as a defect preventive. This he thought worth stressing, as sand control should anticipate trouble and give guidance for prevention, rather than merely explaining what was at fault after the trouble had occurred. He suggested that a correlation of fettling and sand control costs would be worth while considering, as in the smaller foundries the cost of control might readily outweigh the extra cost of fettling inferior finished castings. He agreed with the lecturer that the ideal would be sand delivered to customers' specification, but he thought much difficulty would be encountered in compelling this.

He, like Mr. Shepherd, could not agree with Mr. Thomas that uniformly graded sand was an advantage. As an example of this he mentioned that Mr. Gardom, on opening a new plant, had started with a graded Leighton Buzzard silica sand which gave trouble for a considerable time with poor "moulda-

bility" and lifting power, and a rough casting finish. Not until continued processing had broken down the sand, giving probably a non-uniform grain size, did things improve.

This, he continued, led to the question of what are fines which were always thought to be broken-down silica grains silting up the sand, but which the lecturer suggested are almost exclusively clay or bonding material. Little is really known about this question and he himself had made a number of perfectly good castings using nothing else but fines. He considered it a pity that cores must be made strong enough to prevent breakage on handling, instead of just sufficient strength to suit the mould. He was rather startled to hear from Mr. Thomas that increased moisture contents decreased the dry strength, and as he knew that Mr. Thomas's figures were only on preliminary tests, he felt that this would be investigated further with interest.

Moisture Content

MR. D. CARRICK considered that higher moisture additions in certain core sands were very important, although, broadly speaking, the keeping of the moisture figure down facilitated drying. He had always found that increased moisture gave a stronger and tougher core. Regarding the lecturer's remarks on screening for reclamation of fines to be used again as a bonding material, this appeared to him to be taking bond out merely to replace it with new bonding material, instead of perhaps utilising the old bond by remilling.

MR. THOMAS, in reply, said that on 100-mesh size the optimum moisture was 2¼ per cent.; over this he had experienced a decreasing dry strength. A great deal depended on within what range one was working, as the curve of the graph goes up and drops sharply. In reply to a question as to whether the oil distributes better if the oil or water are added first, although this question had been a "bone of contention" for some time, he himself preferred adding the oil first.

MR. KAIN felt that it was a question of surface tension, and dependent on the wetting qualities of the sand.

Origin of Fines

MR. SHEPHERD, in reverting to the question of fines, said he had never been satisfied that the greater portion of fines came from crushed sand. He believed that silt comes mainly from the ash from the coal dust and had satisfied himself that an increased coal-dust addition caused a proportional increase in the amount of fines. This throws doubt on the idea that fines were broken-down sand grains and was substantiated by milling tests he had carried out, which indicated that no appreciable breakdown of the grains of the average type of sand occurred.

MR. V. N. WOOD asked if the lecturer had any idea as to how often the same sand could be used by remilling without any new addition. He himself had used a remilled sand 20 times before a drop-out in use occurred.

MR. THOMAS, in reply, said that it depended entirely on the quantity of heat put through the sand. He himself had only succeeded in using the same sand six times. In reply to a further question from Mr. Carrick, he said that correlation of sand consumption and metal tonnage showed that changes in the weight of jobs being produced caused a rise and fall in sand consumption.

MR. L. E. SLATER said he had worked with Mr. Thomas on the reuse of sand milled with no new addition when the result had been six moulds. In this job 42 lbs. of metal went into 38 lbs. of sand, which was a very exacting test and probably explained the poor comparison with the figures which Mr. Wood had given.

The meeting finally cordially responded to the vote of thanks, proposed to Mr. Thomas by Mr. H. H. Shepherd.

ANTIQUE CAST IRON IN SURREY

The fashion set by Tijou and his English rivals in the 17th century for decorative wrought ironwork gave way in the following century to plainer designs, and was finally superseded by the cast-iron work so much used by the Adams brothers. Amongst the many examples still to be found in Surrey are the following at Epsom: Flask-shaped vases at Hylands House. Boroque-style vases at The Hylands, and at Woodcote Hall. Wrought-iron railings with cast-iron newels are still to be seen at the Shrubbery in South Street. Pett Place has in its portico columns from Nash's Regent Street colonnade.

The neighbouring village of Ewell also possesses some interesting examples of cast-iron work; Chessington House having guard posts resembling small cannon, whilst at the head of Ewell Springs are to be seen railway verticals with leaf-shaped lance heads carrying classical vases on the standards. It is a regrettable fact that the authorities have caused the removal for scrap of interesting historical work at Woodcote Hotel, No. 1, Woodcote End; at Epsom; at Spring House in Ewell, and from the churchyards of both Epsom and Ewell. The information given above was disclosed in a Paper by Mr. Cloudesley E. Willis, printed in the Collections of the Surrey Archæological Society.

B.S.I. STANDARDS

The monthly information sheet issued by the British Standards Institution announced that new standards have been issued for Domestic Hot Water Supply Boilers (No. 758, Part 3) and Spraying Nozzles (No. 1135—1943). Both cost 2s. each. Amongst overseas standards available for inspection in the Institution's library are two Swiss ones covering cast iron and pure aluminium and aluminium alloys.

LADLE DRYING

By W. Y. Buchanan.

The drying of ladles with coal and wood fires in the foundry is perhaps the most wasteful of all operations entailing the use of fuel now carried on. The operation usually requires to be carried on outside the foundry building because of the acrid wood fumes or heavy black smoke from the coal and large volumes of light feathery ash float about when removing the fire when the ladle is required for casting. The efficiency of the actual drying itself is very poor, since the fire can only be lit up with large pieces of coal of such a size that the air can circulate through the fire. The drying requires several hours, the results are often very indifferent and the discarded fire is seldom more than half burnt when discarded.

The importance of fuel conservation has brought this matter under consideration again and a satisfactory solution of this problem is a matter of direct interest to most foundries. When producer gas is

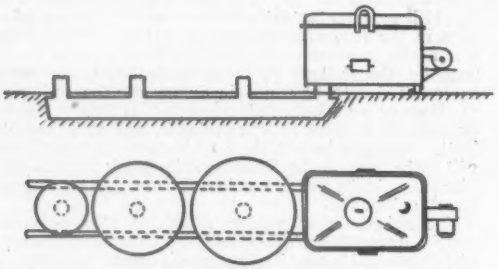

Fig. 1.—Arrangement for Drying Ladles Using a Standard Adelphi Mould Dryer.

available as in the steelfoundries, the drying of ladles is very efficiently carried out and easily arranged. The best substitute for this type of fuel in the ironfoundry is the portable coke-fired mould drier.

An experiment carried out a number of years ago on an 8-ton ladle using coal in the first place, as was the custom previously, and then covering with a large cast-iron plate and using a mould drier for heating, gave rather startling results. In the case of coal, the amount used was 15 cwts.; the heating took place over a period of about 8 hrs. and the ladle was not very hot, while a very large quantity of coal was ultimately discarded unburnt.

With the mould drier blowing downwards into the ladle, which is evidently not the best arrangement, about 98 lbs. of coke was used, and the lining was actually heated red, in less than 2 hrs. This represents a cost ratio in favour of the mould dried of 22.6 to 1. This ladle was eventually scrapped and substituted by two smaller ones, and so these experiments ceased.

Recently the idea was revived because of the excessive quantity of coal being used or wasted for such purposes. One standard Adelphi mould drier was arranged to blow into a narrow brick flue with three outlets directing the gas upwards. These were spaced out at intervals to suit the ladles being dried and making the distance of these outlets from the mould drier as short as possible. Contrary to the usual point of view, ladles can be dried in the inverted position without the slightest danger of the parts falling out of the lining even when rapidly heated. This arrangement works very well indeed.

Adjusting the mould drier to give a large volume of hot air, i.e., directing practically all the air over the fire, a steady temperature of 460 deg. C. is obtained at the delivery tube, burning coke nuts at the rate of 11 to 14 lbs. per hr. When blowing a large volume of air through the fire so as to obtain a maximum temperature, the pyrometer reading in the exit gases of 700 deg. C. was obtained. This allows for ladles being heated rapidly to a red heat if required for special metals requiring high fluidity, taking, say, 40 min. for a 50-cwt. ladle and about 20 min. for a 10-cwt. ladle as the minimum time. The arrangement illustrated dries daily:—One ladle, 50-cwt. capacity; one of 30 cwts., two of 15 cwts., one of 10 cwts., and one ladle of 6-cwt. capacity. After patching and cleaning, with an occasional renewal of the lining of the smaller sizes, which are rammed with rock sand for a total coke consumption of 44 lbs. of coke over 4 hrs. (exclusive of the original fire). In the light of this performance, the quantity of coal used and wasted on this operation previously is perhaps better forgotten.

PUBLICATION RECEIVED

The Journal of the Iron and Steel Institute. Vol. CXLVII. Edited by K. Headlam-Morley. Published by the Institute from 4, Grosvenor Gardens, London, S.W.1.

From the foundry point of view, this volume is interesting, as it contains a review of the work of the Ingot Moulds Sub-Committee by Mr. R. H. Myers. A system of complete technical integration between the foundry and the steelworks is detailed by the publication of a form which starts off with the mixture used in the cupola and ends with a note as to the feature which ended its useful life as an ingot mould. Investigations based on such co-operation form an ideal basis for future research work designed to increase ingot mould life, or perform a similar industrial function. The extracts from current literature on foundry practice are, as usual, as excellent as they are comprehensive. The only criticism we have to make is the continuation of the policy of reproducing photomicrographs linearly reduced. Usually a smaller, yet typical, area reproduced at the magnification of the original photograph gives clearer information, and takes up no more space. The interest of this volume for foundrymen can best be assessed by the fact that the index contains about fifty references to cast iron and castings.

MAGNESIUM FOUNDRY TECHNIQUE

The Coreing up, cleaning, finishing and inspection of a large magnesium casting are detailed

By IAN ROSS

(High Duty Alloys Limited and Magnesium Castings and Products Limited)

(*Concluded from page* 96)

Coreing-up

Sectional thicknesses vary from 10 to 14 m/m. All gauges are periodically checked to ensure correct dimensions. The disposition of the internal ribbing can be clearly seen in Fig. 6, also the large core forming the attachment arms and attachment lugs. Altogether there are ten cores in the mould, including four small cores forming the inspection holes, two of which can be seen at the top of the assembly. Although it is essential to provide good clearances on the cores when lowering the top owing to the particularly friable nature of the sand, special precautions are necessary to ensure that the metal flows only through the correct channels into the mould. Magnesium alloys are notorious for shrinkage defects from hot spots caused by thick flashes, the presence of which inevtiably result in rejected castings. Six main vents are evenly distributed over the core assembly to promote free dispersal of the gases generated during pouring. Metal is poured at a temperature of 740 deg. C. The pour shown in Fig. 7 takes about eighteen seconds. The casting, together with the runners and risers, are shown in Figs. 8a and 8b.

FIG. 6.—MOULD CORED-UP.

FIG. 7.—POURING THE CASTING.

It is perhaps appropriate at this stage to outline some of the principal difficulties encountered as the production of this component proceeded over its first few months. Prior to the war, magnesium castings were not used in Great Britain for the purpose of forming the major structure in the building of aircraft undercarriages. They had been used quite successfully in France, but the aircraft to which they were fitted were much smaller than British, and therefore they were not subjected to the same heavy loading and stress as castings fitted to the heavier types of aircraft. In view of this a very high standard of acceptance was set to ensure the castings being of high quality.

Although acceptable castings were produced from almost the first few attempted, it became apparent that a tendency to shrinkage defects persisted in certain areas, especially in association with ribs and thick sections already mentioned. As is well known, when troubles like these start on large castings they are very difficult to cure. It is almost like "chasing rainbows"—as soon as the trouble is cured in one section, it breaks out in another. The positioning of runner gates, chills and risers was studied and adjusted from time to time to overcome these defects until the optimum condition was obtained. The position of chills on patterns and coreboxes was marked so that this system should be standard. Experiments in variations of pouring temperature were carried out, and the speed of pour timed so that conditions of temperature and solidification in the mould should be, as far as possible, always the same.

With the sand casting of ultra light alloys the liability of blowholes is always present, especially where large moulds and cores are involved. A rigid

Magnesium Foundry Technique

control of the condition of the moulding sand has to be observed. A fairly coarse sand is used to obtain a permeability of over 100 m.l. per min. by A.F.A. standards, and the milling and processing of the sand has to be efficient so that the moisture content can be reduced to below 5 per cent. The skin-drying and core-stoving process are important, and great care should be taken to see that all core vents function properly.

Melting Desiderata

The liability of dross formation in magnesium alloys is probably higher than in any other alloy on account of the strong affinity of magnesium for oxygen. Furnacemen have to be trained to be thorough in fluxing, straining and skimming, so that the metal arrives at the pouring station free from all oxides and flux. Pouring basins are specially designed to effect a smooth entry of metal into the mould. It may have been noticed that the downgate system comprises a group of strip-section downrights. This is normal magnesium foundry practice, and its main function is to obviate any vortex effect. Apart from this, of course, by arranging for several small downrights instead of one big one, a smaller volume of metal passes over a given area of sand surface and therefore there is less chance of any sand attack taking place. Actually the entire runner system is designed to baffle the entry of metal into the actual casting by the horn gate system. The use of horn runners is also a very popular method in magnesium foundries, and this is undoubtedly due to the necessity for such a large amount of bottom running.

These are precautionary measures taken against the occurrence of individual defects encountered from time to time on the job. Experience has shown that the high quality demanded of this component can only be obtained by close attention to every detail of foundry operation.

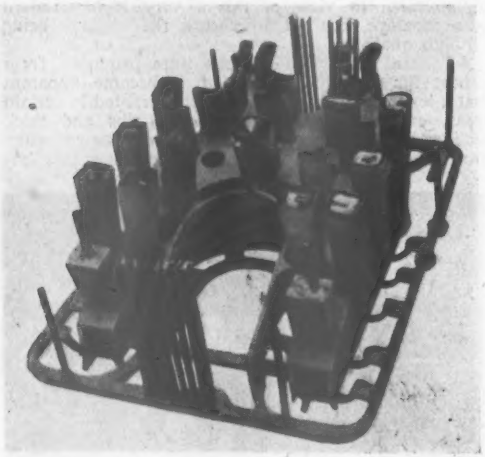

FIG. 8A.—THIS ILLUSTRATION AND FIG. 8B SHOW THE CASTING AS REMOVED FROM THE SAND.

Cleaning Operations

The final foundry operation of knocking out presents no major difficulties, especially now that the facilities of handling have been developed. Naturally, great care has to be taken when the knocking out bars are used inside the casting to avoid damaging the strengthening ribs.

In the early days the fettling operation had to be carried out with what appliances were available. It was a tedious and expensive routine with tools very much "under the job," but castings were required very urgently, and the delivery of new equipment was long delayed.

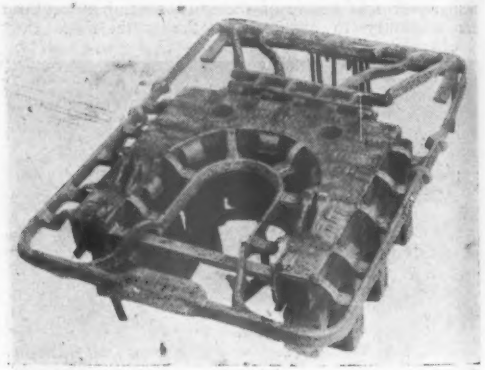

FIG. 8B.

At first all surplus metal, runners and risers, etc., were removed entirely with pneumatic chipping hammers, but it was very soon apparent that to cope with foundry output it would be necessary to institute certain mechanical equipment to speed up the fettling operation. A horizontal handsaw (Fig. 9) was first acquired, which considerably reduced the fettling time, and later a routing machine (Fig. 10) was installed for the special purpose of removing the long feeder pads on the sides of the casting. This machine was by way of an experiment, but further reductions in the fettling time were obtained and the performance of the machine was so satisfactory that two of them are now fully employed to cope with increasing pro-

duction. Certain teething troubles were experienced with the cutters, but these have now been satisfactorily overcome. The high speed of rotation of the cutters, 18,000 r.p.m., demanded many experiments with various cutting steels, and finally tungsten carbide tipped tools are regarded as standard equipment. Further machines are being installed—a vertical band-saw to cut off the side feeders, and two milling machines specially adaptable for cleaning up the whole surface of the casting. By the introduction of this equipment it is considered that the fettling times will be reduced from 56 hours by the old hand method to four or five hours by the mechanised method.

Finishing

After rough fettling the casting is milled with hand-milling machines and shot blasted. It is then annealed to relieve casting stresses in gas-fired heat-treatment

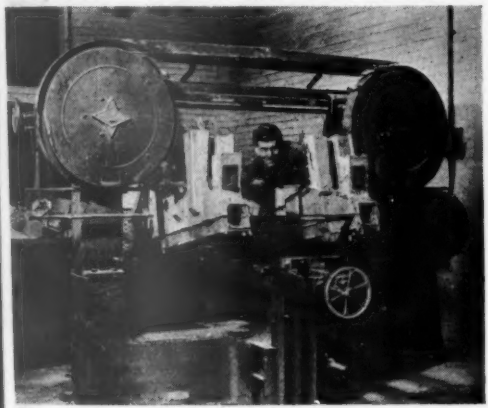

FIG. 9.—A HORIZONTAL BAND SAW IS USED FOR REMOVING RUNNERS AND RISERS.

furnaces for four hours at 300 deg. C. The casting then receives a chromate treatment to protect it against corrosion. Although the corrosion resistance of magnesium alloys does not compare so favourably as aluminium alloys, like iron and steel, they are quite satisfactory in all but very abnormal conditions if chromated and protected by a coat of paint. The chromating treatment is obtained by immersing the castings for thirty minutes in a boiling solution of certain chromium compounds, the composition of which must be closely controlled. Some degree of protection is afforded by the black chromate finish which is formed, but its principal purpose is to provide a satisfactory key for suitable paints to be provided by spray or brush when all machining operations have been completed.

Inspection

The component is then ready for final inspection. Although a careful inspection is carried out after rought fettling a final visual and dimensional inspection is made before it is passed to the X-ray Department. As it belongs to the A.I.D. Class 1 category, each casting must be completely radiographed before release. In the early days of production each casting was covered by no less than twenty-nine radiographic exposures, the positioning and direction of shots being

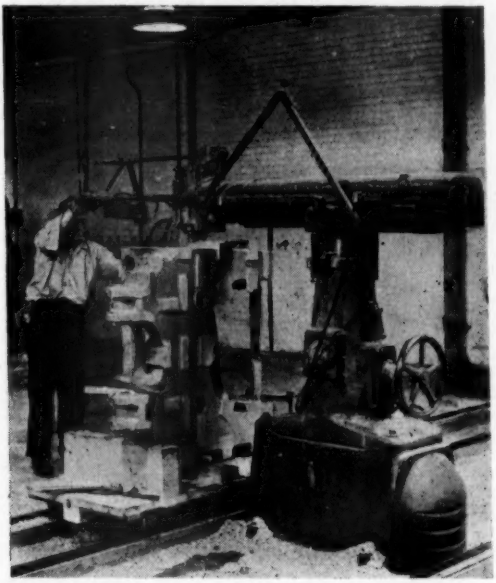

FIG. 10.—ROUTING MACHINES HAVE HELPED TO INCREASE PRODUCTION.

carefully arranged so that the presence of internal flaws in any part of the casting could be detected by scrutiny of the radiographic negatives produced. Special attention was given to highly stressed areas. Dross, blowholes and shrinkage cavities are readily detected by radiologists experienced by the examination of thousands of radiographs. A liaison system is now well established whereby the radiologist, the foundry metallurgist and the foundry supervisory staff are in constant touch with day to day progress and quality of production.

Periodically, reject castings are cut up and completely fractured for examination by the metallurgist and the foundry supervisors. Moulders and core-makers are shown defects brought to light by this break up test or reproduced on the radiograph.

Magnesium Foundry Technique

Undoubtedly by interesting the moulders and core-makers in the job and proving to them the importance of working rigidly to the method laid down, the foundry has been able to maintain the high standard of quality. This is proved by the fact that recently there was a run of sixty-four consecutive castings passed as satisfactory for despatch. It is felt that the principal reason for this good run is the fact that all concerned with the job have realised the importance of paying attention to detail. Most foundrymen will agree that it is the simplest things which cause scrap, and these small points which seem unimportant can only be learned by bitter experience, which takes time.

Even with the advantages of modern science it is considered that the man on the floor is a very important cog in the wheel of successful production. If there is a shop full of good men one can turn out first-class work, but if the men are indifferent, no matter how much care is taken technically, the job suffers. In the foundry, particularly, a little carelessness may cause a large number of scrap castings; therefore it pays to look after the small details, and if a man is trained to do this he automatically takes care of the whole job.

It gives the author a good deal of pleasure to say that the enthusiastic way in which the men engaged on this job have co-operated with us helped the management to develop a reliable method. In conclusion, the author would like to acknowledge with sincere thanks the help that has been given him by Mr. McKenning, the magnesium foundry superintendent, and Mr. Raybould, the foundry metallurgist, in the preparation of this Paper.

FIG. 11.—CLOSE-UP OF THE ROUTING OPERATION.

FIG. 12.—CASTINGS READY FOR DISPATCH.

A ROMAN LEADEN CISTERN

"The Times" recently reported the discovery of a cylindrical Roman leaden water cistern in the Arun marshes west of Wiggonholt. It has a capacity of about 50 galls., and is decorated with a rope-pattern piping in squares, one of which has the Chi-Rho emblem. It is now at Pasham Park, the residence of Mr. Clive Pearson. The cistern was found about 400 yds. west of the Roman baths excavated a few years ago by Mr. S. E. Winbolt. The rope pattern decoration was used by moulders right up to the Tudor period, indicating that venting through the burning away of rope is of considerable antiquity. Its availability was seized up by the ancient moulder as an easy means of decorating his casting. It is often to be seen on both cast-iron grave-stones and early examples of fire-backs made of Wealden iron.

Briquetting of Borings

According to investigations described by J. P. BABITSCH in the Russian "Foundry Journal," alabaster, chalk and coal can be used successfully for briquetting iron and steel turnings, in place of cement. An optimum mixture is stated to be 92 per cent. turnings, 2 per cent. alabaster, 1 per cent. powdered wood-charcoal and 5 per cent. flour. A disadvantage of these briquettes is that they can only be used in limited quantities in furnace charges; good results are obtained with 10 per cent. briquettes, while 15 per cent. can just be tolerated. In these quantities, the quality of the melt is satisfactory, and the percentage of discards is low. To some extent alabaster briquettes can be used in place of steel scrap. The mechanical properties of castings made from charges with these briquettes are claimed to be satisfactory, and sometimes up to 25 per cent. better than those of castings made from similar charges but without briquettes.

A METHOD FOR PLANNING FOUNDRY PRODUCTION

A system is detailed of keeping track of orders and patterns and indicating spare capacity

By "ECOSSAIS"

In large foundries engaged on jobbing work there is need for production to be definitely planned for the benefit of the foundry and customer alike, and a good system will enable the foreman to devote his time to the more practical matters.

Particularly is this the case where there are numbers of small patterns which cannot be described as repetition jobs. In every foundry there is variation in the type of labour available, and this may result in a job, on which the actual moulding time is only a matter of a few hours, having to be held up for days or weeks until a particular man is available.

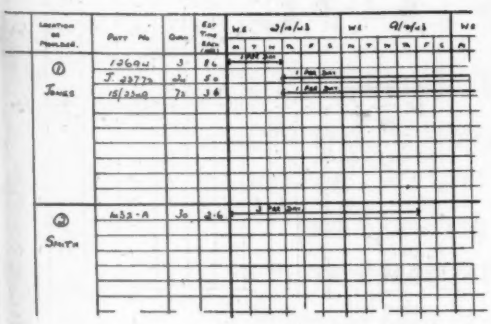

FIG. 1.—CHART DESIGNED FOR THE ALLOCATION OF ORDERS TO FLOOR.

If no system of planning be used, the very desirable practice of giving a reliable delivery date with the acceptance of an order is not possible. The result is the setting up by the customer of progress departments employing "chasers" or clerks sending out a flood of progress inquiries, the idea being that those who shout the loudest will get the best service.

To avoid such methods, and to obtain the good opinion of clients, the following method is suggested:

(1) Sub-divide the whole of the foundry floor into definite areas and obtain a number of black and white plan prints showing these areas, which can be equal to a moulder's daily floor requirements. Keep a current plan up to date with the names of the moulders occupying the different areas.

(2) Next prepare a chart as in Fig. 1, which gives (*a*) area and men; (*b*) pattern number; (*c*) quantity; (*d*) estimated time; and (*e*) columns for weeks divided into working days.

(3) Prepare a rack having double-sided metal holders which can be turned over like the leaves of a book. Each side will hold a standard card as Fig. 2, on which can be inserted the date of the order, requirements, pattern number, delivery date required, delivery date promised, etc., being headed, say, "deliveries week ending February 20, 1943."

On receipt of an order, an approximate estimate of the time per casting is made by the foreman, the suitable area or moulder is noted and transferred to the chart (Fig. 1) as a line indicating the number of days occupied by this particular order, suitable allowance being made at the commencement for core-making, if any. From this line a reliable delivery date can be stated. This order is entered on its appropriate card in the rack previously referred to.

DELIVERIES DUE WEEK ENDING :- February 20, 1943.

Customer.	Order No.	Pattern No.	Description.	Quantity	Delivery Promised.	REMARKS.
Blank & Co.	56447 2-2-43	267536	Nomag Boxes	150	17-2-43	
Jones & Co.	2345 27-1-43	964	C.I. Covers.	300	15-2-43	
Dash & Co.	66786 26-1-43	330416	C.I. Blocks.	2500	13-2-43	1 week overdue
W.H. & Co.Ltd.	P.2897 6-1-43	77894	Nomag Plate	1	20-2-43	
E.N.A. Ltd.	S.0978	X.Q.10.	C.I. Frame.	1	6-2-43	2 weeks overdue
J.J.K. & Co.	S.2248 26-1-43.	S.1416	Nomag Castings.	200	20-2-43	

FIG. 2.—CHART CONTROLLING DELIVERIES.

At the beginning of each week the foundry foreman, dressing-shop foreman, and despatch section will each receive a list of castings due for delivery that week.

This will enable them to make any plans accordingly, and may enable the foundry foreman to hurry through castings which are behind delivery schedule due to scrap or other unforeseen circumstances. Any castings not delivered in the week promised will appear on the following week's card (Fig. 2) as "One week overdue," and if necessary will be continued on the following week's card as "Two weeks overdue." The reminder sheet received by the foreman at the beginning of each week will enable notice to be given to a customer if delivery cannot be made as promised, and thus enable him in turn to remake his plans to utilise machining capacity for other work.

Smaller Types of Work

In the case of bench, plate and small general work, this should be distributed and recorded as far as possible on the basis of a planned day. A small

Planning Foundry Production

card (Fig. 3) should be issued to the moulder each night with a programme for the following day, covering the balance of running jobs and new jobs. The bench production recorded on these small cards should be checked with the dressing shop before being transferred to the book. The practice of piling up patterns on the moulder's bench should be avoided. Any patterns for jobs which are shown as completed and confirmed in the dressing shop should be withdrawn from the moulder for return to the pattern stores. The bench for receiving these patterns should be cleared daily.

Such a system of planning will bring appreciation from customers, as it will reduce the necessity for chasers and progress clerks, such that, in competition with other foundries, an order may be secured on delivery reputation alone, even though other foundries may have quoted lower prices.

In normal times and according to the amount of orders, a clerk may carry out the operation of charting and keeping the other records, obtaining his information from the foreman as required. He could also help the foreman by keeping a loose-leaf book of current orders up to date as regards castings to make, and for despatch in respect of castings not delivered. This book could contain all the orders under the headings of customers' names (Fig. 4), with entries of castings made each day. Ultimately, from the daily scrap sheet, he will indicate under the day on which they occur, the number of castings scrapped and encircle these as examples given. At the end of the week the requirements, less good production, will give the balance outstanding for transfer to the next week's sheet. By means of this book the foreman or progress clerk can detect any cases of patterns not moving, and from the chart shown in Fig. 1 he will be able to locate the pattern and urge the castings. Inspection of this chart will also indicate to the foreman which floors or men are occupied to full capacity and when further loading may be carried out. Although primarily intended for and used with advantage in the foundry, this scheme, by a little modification, could be used for other trades.

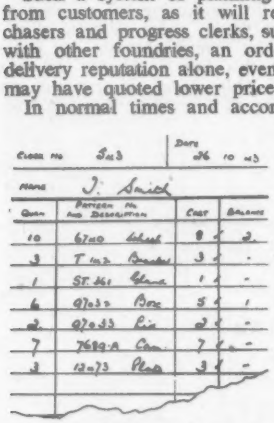

FIG. 3.—SHOWING TYPE OF CARD ISSUED TO THE MOULDER EACH MORNING

The scheme as it now stands has been built up gradually over a period of at least 22 years; the dates on which various items were adopted may be of interest.

January, 1923: Sheet as in Fig. 4.
August, 1927: Chart as in Fig. 1.
August, 1941: Sheet as in Fig. 2.
February, 1943: Card as in Fig. 3.
March, 1943: Area plan of floor spaces.

It is a fact that orders were obtained on the firm's reputation for delivery as promised, even at higher prices than those quoted by other firms. Customers pointed out that they were able to use machine loading efficiently, which was worth a great deal. On the rare occasions when it was found that delivery could not be made at the stated time, the customer was notified immediately the discovery was made. Even this information was valuable, because the customer had ample time to alter his proposed loading scheme.

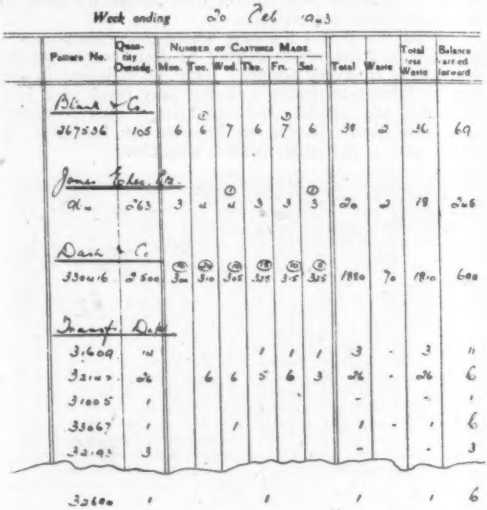

FIG. 4.—SHOWING PAGE FROM DAILY CASTINGS PRODUCTION BOOK.

MOBILE CRANES IN FOUNDRY PRACTICE

Our Engineering Correspondent draws our attention to the suitability of a mobile crane made by Steels Engineering Products, Limited, of Crown Works, Sunderland, for foundry handling propositions. It lifts 5 tons at a 9-ft. radius, three at 13 ft., and 30 cwts. at 19 ft. There are four independent movements—hoisting, slewing, derricking and travelling. Operated by a 35-h.p. petrol engine, it runs on wheels fitted with solid rubber tyres, 720 mm. by 160 m. The maximum height of lift is of the order of 23 ft.

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Thickness	3¾ inches

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NEWS IN BRIEF

THE BUSINESS of machinery merchants and mill furnishers carried on by Smith & Christie, at 378, Abercromby Street, Glasgow, has been sold to John Simpson, Jnr. (Glasgow), Limited, iron and steel merchants, of 97, King Street, Glasgow.

THE IMMEDIATE REVIVAL after the war of the British Industries Fair was urged by Mr. Gilbert Gledhill, M.P. for Halifax, when speaking at Leeds recently. Mr. Gledhill said that the Industries Fair had brought many buyers to this country. It should have ample Government support.

A GLASGOW CONFERENCE on planning for production in industry was attended by nearly 200 representatives of engineering and allied firms in Scotland. The conference was organised by the Royal Technical College in association with the Scottish Education Department and the Regional Production Board.

THE WEST RIDING OF YORKSHIRE BRANCH of the Institute of British Foundrymen meets at the Technical College, Bradford, on Saturday next, February 12, at 6.30 p.m., when a Paper will be given by Mr. Douglas Jepson, M.Sc., on "The Education of Foundry Workers." The Branch Council will meet at 6 p.m.

MR. G. M. GARRO-JONES, M.P., Parliamentary Secretary to the Ministry of Production, speaking at Watford, said that in the last quarter of 1943 the engineering trades had increased their output over normal peace-time production by 200 per cent. The wartime increase in the total hours worked throughout industry in a working week was 23 per cent., of which only 3 per cent. was due to the increase in employment. The rest of the increase was longer hours.

INDICATING that an important group of industrial research laboratories is likely to be developed at Leatherhead, in Surrey, the annual report of the British Electrical and Allied Industries Research Association says that the council of the Association has decided to buy a site adjacent to one secured by the British Coal Utilisation Research Association, and to co-operate with several other interested associations who have found that they will require better facilities to meet the needs of their industries.

THE ANNUAL GENERAL MEETING of "Men of Maudslays," the Society established to commemorate the life work of Henry Maudslay, inventor of the slide-rest and other mechanical devices, will be held at the Institution of Mechanical Engineers, on Saturday, May 6, at 11 a.m., the president, Mr. Walter T. Dunn, in the chair. An exhibition of Maudslay relics, including the famous Maudslay lathe, is being organised. Readers who may have any objects of interest as exhibits are asked to communicate with the hon. secretary, Mr. W. W. S. Robertson, Lynton Works, Bedford, giving particulars and space required.

IT IS REPORTED that Finnish-German negotiations for the exploitation of nickel mines in the Petsamo area of Finland have been concluded at Helsinki. The nickel mines were occupied by the Russians during the war with Finland in 1939-40, but later, under the terms of the peace treaty drawn up in Moscow, the Russians evacuated the Petsamo region, which was left in possession of the Finns. Consequently, since the beginning of the war against Russia these deposits have been worked by the Germans. The recent negotiations are said to have ended in Finnish agreement to a German proposal that exploitation of the nickel deposits be turned over to German companies for 20 years.

PERSONAL

LORD FFRENCH has resigned from the board of Shanks & Company, Limited, Barrhead, Glasgow, and Mr. Richard R. Murray has been appointed a director.

MR. C. L. WAINWRIGHT, of West Hartlepool, manager of the Northern Smelting & Chemical Company, Limited, has taken up a post as assistant manager with the National Smelting Company, Limited.

MR. CHARLES S. LILLICRAP will shortly succeed Sir Stanley Goodall as Director of Naval Construction. Mr. Lillicrap, who is 56, has been at the Admiralty since the last war. In 1936 he was appointed Assistant Director of Naval Construction.

MR. W. B. LORIMER, MR. J. B. MAVOR, and SIR FREDERICK C. STEWART have joined the board of the North British Locomotive Company, Limited, Glasgow. Mr. Lorimer is the son of Mr. William Lorimer, the chairman and managing director. Mr. Mavor is managing director of Mavor & Coulson, Limited. Sir Frederick Stewart is chairman of Thermotank, Limited, and a director of Brown Bros. & Company, Limited.

MR. R. B. SHEPHEARD is to succeed Dr. James Montgomerie as chief ship surveyor of Lloyd's Register of Shipping. Dr. Montgomerie, who was appointed to the position in 1928, has continued in office beyond the normal age for retirement. Mr. R. B. Shepheard will take up duty as from March 1, when the Admiralty, to whom he has been seconded, have agreed to release him. Mr. Shepheard graduated B.Sc. (with special distinction in naval architecture) at Glasgow University in 1923. During his apprenticeship, and later, he was gathering experience with the Fairfield Shipbuilding & Engineering Company, Limited, J. Samuel White & Company, Limited, and the Ardrossan Dockyard. He was appointed a ship surveyor to Lloyd's Register in 1928. Since 1942, he has been working under the Director of Merchant Shipbuilding at the Admiralty, where his special care has been welding.

Wills

BULLOWS, W. L., director of Alfred Bullows & Sons, Limited, ironfounders, Walsall £12,220

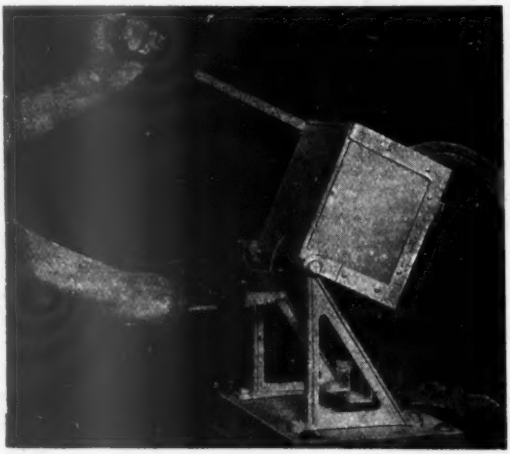
COULTER, H. T., of Belfast, late director of Davidson & Company, Limited, engineers £43,928

MANN, E. A., of Leeds, a director of William Johnson & Sons (Leeds), Limited £4,095

CLAPPERTON, A., of Edinburgh, a director of the Shotts Iron Company, Limited, and other companies £50,290

HATFIELD, W. H., of Sheffield, technical research director, Thomas Firth & John Brown, Limited, and director, Firth-Vickers Stainless Steels, Limited £26,116

. . . for trial heats and experimental work . . .



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Furnace Capacities: 4 ozs. to 40 lbs.
Spark Gap Converters: 3 to 35 K.V.A.
Electronic Equipment: 1 to 50 K.V.A.
Motor Generator Sets: 10 to 45 K.W.

These furnaces may be used for melting in vacuo or under inert atmosphere, full technical information from:

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OBITUARY

MR. PETER BURT, chairman of Acme Wringers, Limited, Glasgow, died recently at the age of 88.

MR. WILLIAM ROBERTS, brassfounder, late of Cleckheaton, died at Scarborough on January 22. He was 86 years of age.

MR. HERBERT LAWSON CRITCHLEY, former general manager of Babcock & Wilcox, Limited, Renfrew, died at Lytham St. Annes on January 24, aged 66.

MR. WILLIAM THOMAS DAVENPORT HARTLEY, a director of Brierley, Collier & Hartley, Limited, engineers, of Rochdale, died on January 26. He was 62 years of age.

MR. HARRY SALMON, J.P., who died on January 17, aged 67, was works director of the Expanded Metal Company, Limited, West Hartlepool, with whom he had been associated since 1896.

MR. HARRY SHANNON died suddenly at his home in North Harrow on January 28, at the age of 73. Mr. Shannon was a director of Ealing Park Foundry, Limited, for many years. He founded the business in 1919, and has been associated with it for over 25 years. He insisted from the earliest days on the making of high quality castings, and it is due to his pioneer work that this foundry has achieved and maintained a particularly high reputation.

DR. A. STANSFIELD, F.R.S.C., Emeritus Professor of Metallurgy at McGill University, died at Montreal on February 5. He was born in this country—at Bradford—in 1871, and was educated at Ackworth School, at Bradford Technical School, and in London at the Royal College of Science and the Royal School of Mines. Between 1891 and 1898 he was engaged on researches on alloys for Sir William Roberts-Austen, and then from 1898 to 1901 was in charge of the metallurgical laboratories of the Royal School of Mines. In 1901, he was appointed Birks Professor of Metallurgy and head of the department of metallurgy at McGill University, Montreal. He continued to occupy the chair until 1936.

THE DEATH at the age of 77 of Mr. Enrique A. Touceda, an authority on the malleable casting industry, is reported from New York. Born in Cuba, he graduated in 1887 with a degree in civil engineering. He joined the Troy Steel & Iron Company, and while in the service of this and other companies carried on a metallurgical consulting practice. In 1898, he went into business for himself in Albany as a consulting metallurgical engineer, and a few years later was appointed professor of metallurgy at Rensselaer Institute, continuing in that capacity for many years in addition to his other activities. In 1912, the American Malleable Castings Association, now the Malleable Founders' Society, engaged Prof. Touceda in a consulting capacity, which position he retained until his death. He was the author of numerous papers on malleable casting practice, and was active in technical affairs of the American Foundrymen's Association. Mr. Touceda was an honorary member of the Institute of British Foundrymen.

COMPANY RESULTS

(Figures for previous year in brackets)

Foster, Yates & Thom—Dividend of 5% (6%).

Heenan, Beddow & Sturmey—Dividend of 15% (same).

Burnell & Company—Trading profit for 1943, £42,744 (£47,417); dividend of 15% (same).

North Lonsdale Iron & Steel—Profit to October 31, £8,781 (£8,237); written off furnaces, etc., £5,727 (land, dwellings, etc., £5,738); forward, £5,042 (£2,489).

John Bolding & Sons—Net profit for 1943, after taxation and preference dividend, £8,528 (£8,048); final dividend of 8% (same), making 12% (same); forward, £30,276 (£27,747).

Westinghouse Brake & Signal Company—Net profit to September 30 last, after tax, £173,274 (£164,711); to staff pensions, £15,000; contingencies, £80,000; dividend of 10% (same) and a cash bonus of 4% (2½%), £78,566 (£70,148); forward, £95,544 (£95,836).

R. A. Lister & Company—Net profit for the year to September 30, £136,839 (£121,007); ordinary distribution of 16% (same), £56,000; preference dividend, £9,000; to general reserve, £35,000 (£25,000); to contingency reserve, £35,790 (£30,000); forward, £72,524 (£71,475).

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Worksop Engineering Company, 13, Bridgegate, Retford, Notts—£2,000. H. Brady and W. A. Watson.

Harefield Engineering Company, 91, Harefield Road, Coventry—£2,000. H. Skidmore and J. C. Payne.

Briggs & Partner, 12, The Park, Southowram, Halifax—Engineers, etc. £2,000. S. Thwaite and F. Briggs.

De-Rusting Processors—£5,000. A. G. Harrison, 42, Boughly Road, Shelton, Stoke-on-Trent, and B. Collins.

H. L. B. Dovaston, 84, High Street, West Bromwich, Staffs—Engineers, etc. £2,000. H. L. B. and L. Dovaston and G. Griffiths.

Robson Engineers (London), 179, Hamilton Road, West Norwood, London, S.E.27—£1,000. J. T., J. F., W. E., and E. A. Robson.

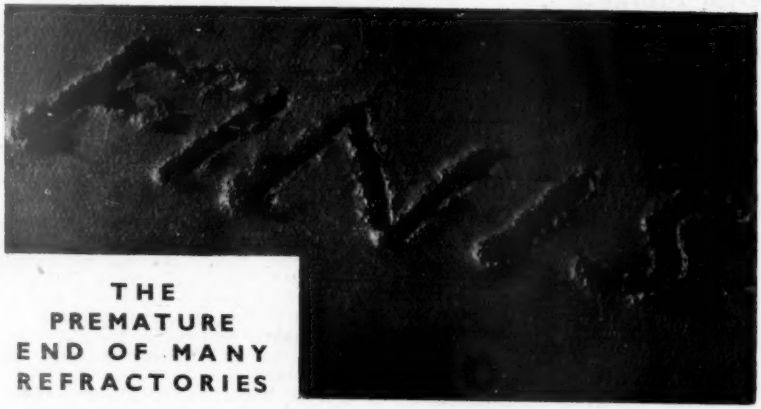
Numetals, 22, High Street, Kingston, Surrey.—To take over a business carried on at Kingston as "Anglo-Metal Products." £2,000. A. J. Gaunt and A. E. Howard.

CONTRACTS OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which tender forms may be obtained.

Derby, February 15—Bar iron, castings, etc., for the Town Council. Mr. M. L. Francis, borough engineer and surveyor, 15, Tenant Street, Derby.

Littleborough, February 21—Iron castings, for the Urban District Council. Mr. G. F. Wild, engineer and surveyor, Council Offices, Littleborough.



THE PREMATURE END OF MANY REFRACTORIES

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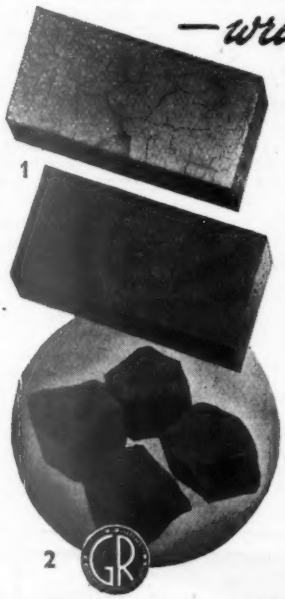

JOINTS are the weakest part of a furnace lining. Ordinary fireclay as a jointing material has certain fundamental disadvantages—it shrinks on drying and again on firing—the bricks do not remain bonded—and fireclay joints are readily attacked by slag. Durax No. 3 Refractory Cement for use with all types of fireclay bricks is a jointing material specially developed to overcome these serious disadvantages. It ensures the thinnest possible joints—sets hard without heat—and does not shrink during drying or firing.

Joints made with Durax No. 3 are as strong and as slag resistant as the fireclay bricks themselves. Its use ensures sound and homogeneous structures from which users can expect long life with a minimum of repairs. Full details on request.

DURAX No. 3 REFRACTORY CEMENT

NO SHRINKAGE. *Illustration (1) shows one firebrick coated with fireclay and the other with Durax No. 3. Both were allowed to dry at atmospheric temperature. The results are easily comparable in the photographic reproductions.*

STRENGTH. *Illustration (2) shows two test pieces allowed to dry at atmospheric temperature, and one fired to 1500° C. Tensile strength results — Unfired: 115 lbs. per sq. in. Fired: 912 lbs. per sq. in.*

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Raw Material Markets

IRON AND STEEL

Reflecting the reduced tempo of activity in the foundry trades, there has latterly been a shrinkage in the volume of delivery specifications for No. 3 iron. The heavy engineering foundries are still fairly busy, but even here conditions are somewhat patchy. Light-castings makers and jobbing foundries are using reduced tonnages of iron. While these conditions are most marked in regard to high-phosphorus iron, there has also been a shrinkage in the call for low- and medium-phosphorus grades, which are now obtainable at short notice. Refined iron makers seem to be disposing of their output without much difficulty, and hematites are the only grades of iron the supply of which is pronouncedly short of requirements. These conditions in the hematite trade have, of course, prevailed for some considerable time past, and former users have been compelled under the spur of necessity to adapt their works' practice to the employment of substitute irons or scrap.

Blast-furnace coke supplies are still coming to hand in adequate volume, and although the extensive use of native ironstone of low iron content tends to keep down the production of pig-iron, there is no indication of any more generous allocations of high-grade imported ores. The wagon shortage is resulting in delayed deliveries of foundry coke, and works that accumulated reserves when supplies were more easily secured now find these stocks standing them in good stead. Most foundries, however, are getting enough fuel to enable them to carry on. Other foundry requirements are coming through fairly satisfactorily. Good cast-iron scrap is by no means plentiful, but foundries are obtaining enough melting material in the form of pig-iron or scrap to meet their requirements.

Most of the re-rollers are now so well placed for supplies of material that they can contemplate with equanimity any possibility of a brief interruption in the flow of semis from the steelworks. Considerable tonnages of American semis have recently be released, and, as British steelmakers have been providing prime and defective billets, sheet bars, crops, etc., on a scale sufficient for current needs, the re-rolling industry has built up stocks to substantial proportions.

With the exception of heavy structural sizes, there is no slackening in the demand for finished steel products, and some of the mills are fully booked for the current period. There is no easement in the insistent call for steel plates and a consequence of the recent changes in shipyard programmes seems to have been a marked expansion in the call for heavy sheets. The galvanising shops are almost wholly idle, but the demand for flat and corrugated sheets is quite abnormal.

NON-FERROUS METALS

The cut in the purchases of copper from Northern Rhodesia is still the topic of conversation in metal-trade circles. It was obvious that curtailment of output would be necessary sooner or later, but the urge for increased production of all materials has been such that few people contemplated a cut in the non-ferrous metals field before the end of the war. It is obvious that the supply position of copper is well assured and the decision to reduce the output leads to the thought that other metals may be similarly affected. It seems unlikely that there can be a reduction in the cases of lead and spelter. Broadly speaking, one is not mined without the other, and though lead has been plentiful in comparison with some other metals throughout the war period, there is no large surplus of zinc, despite the easier shipping situation and the concessions which have been made recently as regards galvanising. Moreover, it is obvious that, when building starts again after the war, a big tonnage of lead will be required, and it would be wise to have stocks on hand for this purpose.

There can be no question of cutting tin production while the United Nations have to do without the metal previously obtained from mines now under Japanese control; indeed, it would seem that the utmost economy will need to be exercised in the use of this metal so long as the war continues. The position in aluminium is rather different. A cut in production has already been made in the United States, and it was suggested when the reduction was announced that Canada and the United Kingdom might follow suit. It was not thought that Britain could have much surplus capacity in this metal, rather that all-out production would seem to be likely so long as hostilities continued. It is now officially stated, however, that a curtailment of United Kingdom aluminium production has been decided upon.

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